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Citation for published version:

Deary, IJ 1998, 'Differences in mental abilities', *British Medical Journal (BMJ)*, vol. 317, no. 7174, pp. 1701-1703. <https://doi.org/10.1136/bmj.317.7174.1701>

Digital Object Identifier (DOI):

[10.1136/bmj.317.7174.1701](https://doi.org/10.1136/bmj.317.7174.1701)

Link:

[Link to publication record in Edinburgh Research Explorer](#)

Document Version:

Publisher's PDF, also known as Version of record

Published In:

British Medical Journal (BMJ)

Publisher Rights Statement:

© Deary, I. J. (1998). Differences in mental abilities. *BMJ*, 317(7174), 1701-1703 doi: [10.1136/bmj.317.7174.1701](https://doi.org/10.1136/bmj.317.7174.1701)

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cal context.¹¹ In the future, brain drugs may be given not only as treatment against a wider backdrop of brain organisation but to provide insights into the basic nature of consciousness itself.

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Differences in mental abilities

Ian J Deary

People value their thinking skills and woe betide anyone who tries to measure them. Both the measurer and the yardstick are liable to be sacrificed on the altar of public ridicule. The professionalisation of this expert bashing may be seen in one of the bestselling books about measuring IQ (intelligence quotient)—Stephen Jay Gould's *The Mismeasure of Man*, now in its second edition.¹ Never mind that it leaves the reader uninformed about the successes of research on differences in human intelligence or that it has been deemed misleading by the cognoscenti,^{2,3} it satisfies our desire to tar and feather experts who dare to measure what we value about ourselves and wish to remain mysterious and complex.

To study differences in mental abilities is to share the predicament of meteorologists. These scientists deal with an aspect of our everyday lives about which most of us feel free to speak with authority unlike, for example, atomic theory or plate tectonics. Meteorologists must simultaneously develop constructs and give practical predictions, which affect our lives. Their measurement tools and the mathematical framework behind them are formidable. They are playing a stochastic game, getting it more right than wrong over the entire season. However, we want them and IQ testers to be right every time or for every person: deterministic rather than stochastic.

Is there one type of intelligence?

If a range of diverse mental tests assessing, for example, language, reasoning, memory, spatial ability, and psychomotor speed is administered to a broad sample of any population, all of the tests will have positive correlations with almost all of the others.⁴ From the nearly universal positive matrix of correlations may be extracted a general factor accounting for about half of the variance in test scores. Sometimes called general intelligence, or *g*, it is an empirical finding, a statistical result, and its nature is as yet unknown. It was discovered by Charles Spearman, a British psychologist, in 1904. Whether better considered a useful statistical summary or a potentially biological source of

Summary points

Differences in mental abilities have a hierarchical structure, from narrow specific abilities to general ability

Environmental and genetic contributions to these differences are sizeable, the genetic contribution possibly increasing with age

Differences may change or remain stable during the adult lifespan, stability being especially high for verbal abilities

Differences in mental ability have some modest predictive validity for real life outcomes

Cognitive and biological bases of differences in mental ability are being explored but are not yet understood

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BMJ 1998;317:1701-3

variance, it is often the best practical predictor obtainable from a battery of mental tests.

g is not the whole story. In the associations among test scores, types of ability—verbal, spatial, memory, and so forth—are grouped, which reminds us that we all have a profile of mental strengths and weaknesses. And there are more specific abilities too. But these specific abilities and the group factors are all positively correlated: people who are high scorers on one will tend to be high scorers on all of them.

The consensus about this description of differences in human ability as a hierarchy of increasingly general variance—from narrow abilities through group factors to general intelligence—has been arrived at because single large studies⁵ and reanalyses of hundreds of data sets⁴ point towards the same model. Thus, when a person's ability is to be measured it is necessary to consider the generality of the measure needed and the particular ability type that is of interest.

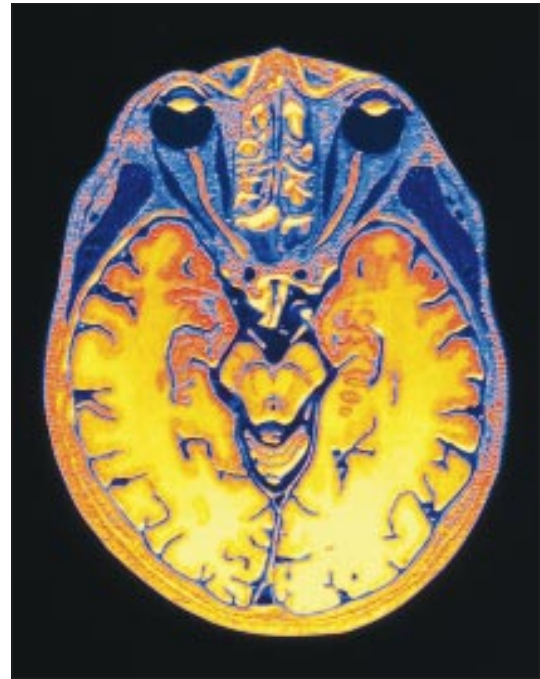
Does intelligence stay the same through our lives?

When several hundred Canadian soldiers serving in the second world war were retested 40 years later with the same test battery that they had taken at call up the correlations were high.⁶ Across the 40 year gap between the ages of 25 and 65 the stability coefficient of individual differences for the verbal ability latent trait was around 0.9, but for non-verbal ability it was around 0.6. Therefore we can see that different aspects of human intelligence show different degrees of stability across adulthood. Generally, abilities that are concerned with stored information and knowledge (crystallised intelligence) are more consistently stable than abilities that are concerned with thinking under time pressure with new materials (fluid intelligence).

Apart from the matter of whether bright 25 year olds tend to be bright 65 year olds (they do), does overall ability decline with age? Again, yes and no.⁶ Verbal abilities and knowledge hold up well or increase until old age, though fluid intelligence decreases in most people after young adulthood. Finding the sources of stability and change in human abilities is a lively area of investigation. The increasing numbers of people surviving to a healthy old age have made us aware that humans show individual differences in how their mental abilities fare with time. Finding the sources of such differential cognitive ageing is now a research priority. Though studies are incomplete, several factors may be protective of mental ability level—namely, being free of chronic disease, living in a complex and intellectually stimulating environment, having a flexible personality in midlife, living with a partner of high ability, maintaining speed of information processing, being satisfied with life in middle age.⁷

Is intelligence inherited or built on experience?

Evidence from family, twin, and adoption studies shows a heritable component in differences in human ability.⁸ These studies are also the best evidence that



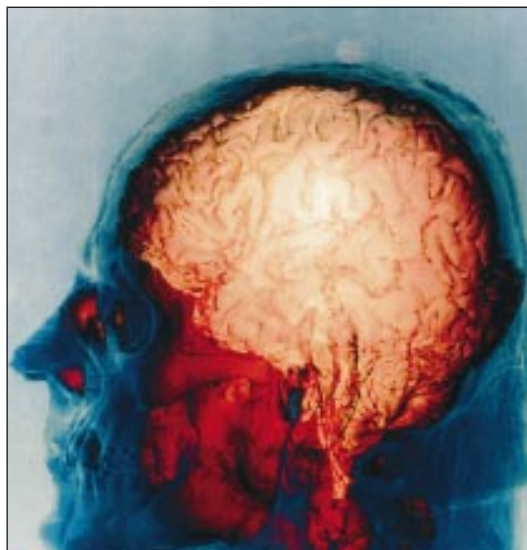
A healthy brain

environment plays a large part. Earl Hunt, an eminent researcher on intelligence, says that the heritability of differences in human intelligence lies somewhere between 40% and 80% and that it does not matter a great deal exactly where within this range.

However, there are counterintuitive details in this crude estimate. The heritability of psychometric intelligence rises as we get older and experience the world more.⁹ The big slice of variance that the environment provides is largely unconnected with our family upbringing and mostly to do with the environment we experience that is distinct from our parents' efforts and that shared with our siblings. People often assume that genetics must be connected with stability in intelligence and the environment with change. This is not necessarily so. Genes may affect changes in intelligence too.

Is intelligence important for success in life?

High scores in psychometric tests are not the only things to determine success. Aspects of personality—motivation, social position, not to mention luck—all have a say. We all know people who are good at IQ-type tests but have underperformed, and we are all pleased for people who have an average score but excel. However, ability as measured in IQ-type tests has some predictive validity. It is not necessarily a strong effect but tends to be as strong as or stronger than any other single psychosocial variable that has been concocted by social scientists. Among the less contentious, but still disputed, material presented in *The Bell Curve*¹⁰ was data from the national longitudinal study of youth, in which thousands of Americans were given a validated battery of IQ-type tests in their late teens and followed up many years later. If we take just white people and control for social class at age 18, those with higher IQs were subsequently less likely to be below the poverty line, to drop out of high school, to be unemployed, to



3-D image of cerebrum created by recombining computed tomograms and magnetic resonance scans

have a baby of low birth weight and more likely to get a college degree. These types of association defy easy causal explanations but show that something captured in the IQ test shares some variance with later fame and fortune.

Are the brain mechanisms that make people different in psychometric intelligence understood?

No, but it is one of the liveliest areas of current research.¹¹ Several cognitive and biological factors are correlated with scores in tests of mental ability. People with higher psychometric intelligence tend to have larger brains, perhaps more efficient brain metabolism, faster reaction times, distinctive brain electrical responses to stimuli, more efficient sensory processing, and a better working memory. Most of these correlations are modest—the answer to what it means to be high in any given mental ability will not be a simple one. The direction of association in the relations is often unclear: high ability might cause, say, changes in brain event related potentials or the reverse, or their shared variance might be caused by another variable. The mechanisms of these associations are not understood. For example, we do not understand why people who score well on IQ-type tests tend to have larger brains, as measured by magnetic resonance imaging.

Are men or women more intelligent?

On tests of general ability, or on summary scores of large test batteries, men and women tend to come out at about the same scores, though there are differences in some of the group abilities.⁴

I recently replicated a finding in psychology students. A few hundred students in my first year lecture class were told about the normal distribution of IQ, with a mean of 100 and a standard deviation of 15 points. They were then asked to estimate their own and their mother's and father's IQs on this scale. The boys estimated their own and their father's IQs at an identical mean of 121 points, not far from what we know to be the measured value of our undergraduates. They estimated their mother's IQ at a mean of 111, two thirds of a standard deviation lower. The girls estimated their own IQ at a mean of 112, but replicated the boys' feelings about having cleverer fathers (mean 116 points) than mothers (mean 108 points). A convincing explanation for these opinions from young people who have never been told that sex significantly affects IQ scores has eluded psychologists. Any suggestions?

Conclusions

Perhaps the value we place on our intelligence properly induces us to rail against its premature metrification. Or perhaps it offends sensibility to talk about a matter best left private. Almost 350 years ago Thomas Hobbes, in *Leviathan*, recognised the tendency to court controversy of those who had the temerity to try to measure the wits of man:

For such is the nature of men, that howsoever they may acknowledge many others to be more witty, or more eloquent, or more learned; yet they will hardly believe

there be many so wise as themselves; for they see their own wit at hand and other men's at a distance. But this proveth rather that men are in that point equal, than unequal. For there is not ordinarily a greater sign of the equal distribution of anything, than that every man is contented with his share.¹²

For those who want to read more about differences in human intelligence I advise an accessible and disinterested review published under the auspices of the American Psychological Association, one which supports Churchill's dictum that "jaw jaw is better than war war." After the furore surrounding *The Bell Curve* the association appointed a task force of psychologists jointly to write and co-sign a statement on what is currently known and unknown about human intelligence. The authors were well known in the discipline, not least for their diversity of opinions on differences in human intelligence. Yet, they managed after meeting, arguing, and drafting and redrafting to agree and jointly sign a review statement on the science of human intelligence—a haven of sensible, evidence based agreement in the battleground of differences in intelligence.¹³

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Favourite prayers

Peace in the city,
Peace in the house,
Peace in my heart,
And peace everywhere.

From "A Prayer for Peace"
by Joy Calvert,
Londonderry Primary School, and
Alicia O'Rourke,
St Finian's Primary, Newtownards,
Northern Ireland.

From *Favourite Prayers*
compiled by Deborah Cassidi;
Cassell, 1998;
ISBN 0304 70315 X,
price £9.99.